

AMENDMENT TO CLAIMS

With respect to the above-identified Office Action, please amend the Claims as follows:

1. (Currently Amended) An inflatable heating device comprising:
a generally cylindrical body having an inner surface and an outer surface, said inner surface of said cylindrical body of the heating device defining a generally hollow inflation chamber, said body including a flexible matrix and a plurality of nonmetallic, electrically conductive fibers embedded within said flexible matrix, said flexible matrix being cured to a stable elastomeric state by electrical resistive heating of said fibers, said body being capable of expanding and returning to an original form, and electrical cable lines connecting the electrically conductive fibers in the generally cylindrical body to an electrical energy source for providing electrical energy to the electrically conductive fibers to resistively heat the electrically conductive fibers.
2. (Previously Presented) The inflatable heating device of claim 1 wherein said flexible matrix comprises one or more materials selected from the group consisting of fluorosilicone and fluorocarbon.
3. (Previously Presented) The inflatable heating device of claim 1 wherein said fibers are carbon fibers.
4. (Previously Presented) The inflatable heating device of claim 1 wherein said fibers are arranged helically and positioned at an angle of +/- 45° with respect to the longitudinal axis of said body.
5. (Previously Presented) The inflatable heating device of claim 4 wherein said fibers are arranged in one of tows and bundles to provide approximately 50-90% coverage of said body.
6. (Previously Presented) The inflatable heating device of claim 1 wherein said fibers comprise a non-woven tape.
7. (Withdrawn) A process of forming an inflatable heating device comprising the steps of applying a layer of uncured sheets of a fluorosilicone material to a mandrel;
winding a plurality of carbon fiber in a helix onto said fluorosilicone material layer;

applying a layer of uncured sheets of fluorocarbon material over said carbon fibers;

applying a radially inward pressure to said fluorosilicone layer, carbon fibers and fluorocarbon layer; and

applying an electric current to said carbon fibers to resistively heat said carbon fibers to cure said fluorosilicone layer and said fluorocarbon layer to form a cured structure.

8. (Withdrawn) The process of claim 7 further comprising the steps of removing said electric current from said carbon fibers;

removing said radially inward pressure from said fluorosilicone layer;

carbon fibers and fluorocarbon layer;

allowing said cured structure to cool; and

removing said cured structure from said mandrel.

9. (Withdrawn) The process of claim 7 wherein said applying an electric current step comprises resistively heating said carbon fibers to heat said fluorosilicone layer and said fluorocarbon layer to a temperature of approximately 300°F for approximately 45 minutes.

10. (Withdrawn) The process of claim 9 further comprising removing said fluorosilicone layer, carbon fibers and fluorocarbon layer from said mandrel, and heating said fluorosilicone layer, carbon fibers and fluorocarbon layer to a temperature greater than 300°F.

11. (Withdrawn) The process of claim 7 further comprising incorporating a layer of uncured silicon sheets in said cured structure.

12. (Currently Amended) An apparatus for curing a pre-preg repair material supporting a heat curable resin for in-situ repair of a conduit, comprising:

an elastomeric composite having a first end and a second end, wherein the composite includes a non-ferrous heating element disposed within a thermoset resin matrix;

a first end piece fixedly attached to the first end of the composite and having an air port for communication with a compressed air source, a

vacuum port for communication with a vacuum supply source and at least one electrical cable port ~~for communication with to convey electric current to the non-ferrous heating element from~~ a power supply source; and a second end piece fixedly attached to the second end of the composite, wherein the composite, the first end piece, and the second end piece form ~~an~~ a generally hollow inflation chamber.

13. (Original) The apparatus of Claim 12 wherein the thermoset resin is selected from the group consisting of fluorocarbon and fluorosilicone.

14. (Original) The apparatus of Claim 12 wherein the heating element includes a plurality of braided fibers comprising of temperature tolerant fiber braids and electrically conductive fiber braids.

15. (Original) The apparatus of Claim 14 wherein the braided fibers interact to define a braid angle measure at +/- 45 degrees.

16. (Original) The apparatus of Claim 14 wherein the electrically conductive fiber braids are carbon filaments.

17. (Canceled)

18. (Currently Amended) The apparatus of Claim 12 wherein the heating element includes a plurality of filament wound fibers comprising of temperature tolerant fiber windings and electrically conductive fiber windings.

19. (Currently Amended) The apparatus of Claim 18 wherein the wound fibers interact to define ~~and~~ an angle measure at +/- 45 degrees.

20. (Original) A method for repairing a damaged section of a conduit comprising the steps of:

providing an elastomeric composite having a first and second end, wherein the composite includes a heating element disposed within a thermoset resin matrix;

fixedly attaching a first and second end piece respectively to the first and second ends of the composite, wherein the first end piece, the second end piece, and the composite form a heating/inflation module;

removably attaching a pre-preg to an outer surface of the composite, wherein the pre-preg includes a structural fiber matrix supporting a heat curable resin;

positioning the module with the attached pre-preg into the conduit at a damaged location;

inflating the module to a predetermined internal air pressure to expand the composite and press the pre-preg against an inside surface of the conduit;

curing the resin of the pre-preg by causing an electrical current to flow in the heating element to resistively heat the module to a predetermined temperature; and deflating the module and removing it from the conduit.

21. (Currently Amended) An inflatable heating device comprising:
a generally cylindrical body having an inner surface and an outer surface, said inner surface of said cylindrical body of the heating device defining a generally hollow inflation chamber, said body comprising a thermoset resin matrix and a plurality of carbon fibers embedded within said matrix, said carbon fibers being arranged helically and positioned at an angle of +/- 45 degrees with respect to the longitudinal axis of said body, said matrix being cured to a stable elastomeric state by electrical resistive heating of said carbon fibers, said body being capable of expanding and returning to an original form, and electrical cable lines connecting the carbon fibers in the generally cylindrical body to an electrical energy source for providing electrical energy to the carbon fibers to resistively heat the carbon fibers.

22. (Currently Amended) A system for in-situ repair of a conduit, comprising:

an apparatus including an elastomeric composite having a first end and a second end, wherein the composite includes a non-ferrous heating element disposed within a thermoset resin matrix;

a first end piece fixedly attached to the first end of the composite and having an air port for communication with a compressed air source, a vacuum port for communication with a vacuum supply source and at least one electrical cable port to convey electric current to the non-ferrous heating element from for communication with a power supply source;

a second end piece fixedly attached to the second end of the composite, wherein the composite, the first end piece, and the second end piece form an inflation chamber; and,

a pre-preg removably attached to an outer surface of the composite of the apparatus, the pre-preg including a structural fiber matrix supporting a heat curable resin.

23. (Withdrawn) A method for in-situ repair of a conduit comprising:

providing a generally cylindrical body having an inner surface and an outer surface, said body containing a flexible elastomeric matrix and a plurality of nonmetallic conductive fibers arranged helically about said body so as to expand and contract and contract with the application of air pressure and vacuum pressure to said inner surface of said body;

providing an electrical power source connected to said fibers;

resistively heating said fibers by the electrical power source to cure the elastomeric matrix of the cylindrical body;

providing a pre-preg removably attached to an outer surface of said body; and resistively heating said fibers by the electrical power source to cure the pre-preg.

24. (Withdrawn) The method of claim 23 further comprising providing a controller to monitor and vary the temperature of the fibers.

25. (Withdrawn) The method of claim 24 further comprising monitoring and varying the temperature of said fibers to achieve a uniform cure in the pre providing a pre-preg removably attached to an outer surface of said body; and. resistively heating said fibers by the electrica1 power source to cure the pre-preg.

26. (New) An inflatable heating device having a generally cylindrical body for internal in-situ repair of pipe shaped objects comprising:

an elastomeric seamless composite closed body having a generally cylindrical shape formed of at least one layer of a flexible elastomeric material having a first inner surface and a second outer surface, a plurality of nonmetallic, electrically conductive fibers located substantially throughout the length of the cylindrical shaped body between the first inner surface and second outer surface of the flexible elastomeric material;

at least one electrically conductive cable port connecting the electrically conductive fibers to an electrical power source; and

at least one air port for inflation and deflation of the closed body.

27. (New) The inflatable heating device of Claim 26 wherein the generally cylindrical body has an outer diameter sized to allow the second outer surface to contact an inner surface of a repair object to transfer electrical resistive heat energy created by the conductive fibers located between the first inner surface layer and second outer surface layer when energized by the electrical power source and the body is inflated.

28. (New) The inflatable heating device of Claim 26 further comprising components to monitor heat of the composite body and to control resistive heating.

29. (New) An inflatable heating device comprising a generally cylindrical body having an inner surface and an outer surface, said inner surface of said cylindrical body of the heating device defining a generally hollow inflation chamber, said body including a flexible matrix and a plurality of nonmetallic, electrically conductive fibers embedded within said flexible matrix, said fibers being non crimped, said flexible matrix being cured to a stable elastomeric state by electrical resistive heating of said fibers, said body being capable of expanding and returning to an original form, and electrical cable lines connecting the electrically conductive fibers in the generally cylindrical body to an electrical energy source for providing electrical energy to the electrically conductive fibers to resistively heat the electrically conductive fibers.

30. (New) The inflatable heating device of Claim 29 further comprising components to monitor heat of the composite body and to control resistive heating of the electrically conductive fibers.

31. (New) The inflatable heating device of claim 29 wherein said flexible matrix comprises fluorosilicone.

32. (New) The inflatable heating device of claim 29 wherein said fibers are carbon fibers.

33. (New) The inflatable heating device of claim 29 wherein said carbon fibers are angled at an angle of +/- 45 degrees with respect to said longitudinal axis of said body.

34. (New) The inflatable heating device of claim 33 wherein said carbon fibers are arranged in one of tows and bundles to provide coverage in a range of 50% to 90% of said body.

35. (New) The inflatable heating device of claim 29 wherein said carbon fibers are in the form of a non-crimped tape.

36. (New) An apparatus for curing a heat curable resin of a pre-preg repair material supporting a heat curable resin for in-situ repair of a conduit, comprising:

an elastomeric composite having a first end and a second end, wherein the composite includes a non-ferrous heating element disposed within a thermoset resin matrix wherein the non-ferrous heating element is selected from the group consisting of carbon fibers, woven fibers containing carbon filaments, braided carbon fibers, braided fibers containing carbon filaments, crimped carbon fibers, crimped fibers containing carbon filaments, carbon fiber tapes, tapes of fibers containing carbon filaments, non crimped carbon fibers, non crimped fibers containing carbon filaments, filament wound fibers containing carbon filaments, stitched bonded fibers containing carbon filaments, a plurality of non crimped fibers containing carbon filaments that are arranged in a selected pattern, graphite fibers, woven fibers containing graphite filaments, braided graphite fibers, braided fibers containing graphite filaments, crimped graphite fibers, crimped fibers containing graphite filaments, graphite fiber tapes, tapes of fibers containing graphite filaments, non crimped graphite fibers, non crimped fibers containing graphite filaments, filament wound fibers containing graphite filaments, stitched bonded fibers containing graphite filaments, a plurality of non crimped fibers containing graphite filaments that are arranged in a selected pattern ;

a first end piece fixedly attached to the first end of the composite and having an air port for communication with a compressed air source;

a vacuum port for communication with a vacuum supply source and at least one electrical cable port to convey electric current to the non-ferrous heating element from a power supply source; and

a second end piece fixedly attached to the second end of the composite, wherein the composite, the first end piece, and the second end piece form a generally hollow inflation chamber.

37. (New) The inflatable heating device of Claim 36 further comprising components to monitor heat of at least a portion of the elastomeric composite and to control resistive heating.
38. (New) The apparatus of Claim 36 wherein the thermoset resin of the elastomeric composite is selected from the group consisting of fluorocarbon and fluorosilicone.
39. (New) The apparatus of Claim 36 wherein the heating element includes a plurality of braided fibers comprising of temperature tolerant fiber braids and electrically conductive fiber braids.
40. (New) The apparatus of Claim 38 wherein the braided fibers interact to define a braid angle measure at +/- 45 degrees.
41. (New) The apparatus of Claim 38 wherein the electrically conductive fiber braids are carbon filaments.
42. (New) The apparatus of Claim 36 wherein the heating element includes a plurality of filament wound fibers comprising of temperature tolerant fiber windings and electrically conductive fiber windings.
43. (New) The apparatus of Claim 42 wherein the filament wound fibers interact to define an angle measure at +/- 45 degrees.
44. (New) A method for repairing a damaged section of a conduit comprising the steps of:

providing an elastomeric composite having a first and second end, wherein the composite includes a heating element disposed within a thermoset resin matrix wherein the non-ferrous heating element is selected from the group consisting of carbon fibers, woven fibers containing carbon filaments; braided carbon fibers, braided fibers containing carbon filaments, crimped carbon fibers, crimped fibers containing carbon filaments, carbon fiber tapes, tapes of fibers containing carbon filaments, non crimped carbon fibers, non crimped fibers containing carbon filaments, filament wound fibers containing carbon filaments, stitched bonded fibers containing carbon filaments, a plurality of non crimped fibers containing carbon filaments that are arranged in a selected pattern, graphite fibers, woven fibers containing graphite filaments, braided graphite fibers, braided fibers containing

graphite filaments, crimped graphite fibers, crimped fibers containing graphite filaments, graphite fiber tapes, tapes of fibers containing graphite filaments, non crimped graphite fibers, non crimped fibers containing graphite filaments, filament wound fibers containing graphite filaments, stitched bonded fibers containing graphite filaments, a plurality of non crimped fibers containing graphite filaments that are arranged in a selected pattern;

fixedly attaching a first and second end piece respectively to the first and second ends of the composite, wherein the first end piece, the second end piece, and the composite form a heating/inflation module;

removably attaching a pre-preg to an outer surface of the composite, wherein the pre-preg includes a structural fiber matrix supporting a heat curable resin;

positioning the module with the attached pre-preg into the conduit at a damaged location;

inflating the module to a predetermined internal air pressure to expand the composite and press the pre-preg against an inside surface of the conduit;

curing the resin of the pre-preg by causing an electrical current to flow in the heating element to resistively heat the module to a predetermined temperature; and

deflating the module and removing it from the conduit.

45. (New) The method of Claim 44 further comprising monitoring the temperature of at least a portion of the composite and controlling the resistive of the heating element.

46. (New) An inflatable heating device comprising:

a generally cylindrical body having an inner surface and an outer surface, said inner surface of said cylindrical body of the heating device defining a generally hollow inflation chamber, said body comprising a thermoset resin matrix and a plurality of non crimped carbon fibers embedded within said matrix, said carbon fibers being arranged helically and positioned at an angle of +/- 45 degrees with respect to the longitudinal axis of said body, said matrix being cured to a stable elastomeric state by electrical resistive heating of said carbon fibers, said body being capable of expanding and returning to an original form, and electrical cable lines connecting the

carbon fibers in the generally cylindrical body to an electrical energy source for providing electrical energy to the carbon fibers to resistively heat the carbon fibers.

47. (New) The inflatable heating device of Claim 46 further comprising components to monitor heat of at least a portion of the cylindrical body and to control the resistive heat of the carbon fibers.

48. (New) A system for in-situ repair of a conduit, comprising:

an apparatus including an elastomeric composite having a first end and a second end, wherein the composite includes a non-ferrous heating element disposed within a thermoset resin matrix wherein the non ferrous heating element contains fibers selected from a group consisting of carbon fibers, graphite fibers, fibers containing carbon filaments, and fibers containing graphite filaments;

a first end piece fixedly attached to the first end of the composite and having an air port for communication with a compressed air source, a vacuum port for communication with a vacuum supply source and at least one electrical cable port to convey electric current to the non-ferrous heating element from a power supply source;

a second end piece fixedly attached to the second end of the composite, wherein the composite, the first end piece. and the second end piece form an inflation chamber; and

a pre-preg removably attached to an outer surface of the composite of the apparatus, the pre-preg including a structural fiber matrix supporting a heat curable resin.

49. (New) The inflatable heating device of Claim 48 further comprising components to monitor heat of at least a portion of the elastomeric composite and to control the heating element.

50. (New) An inflatable heating device having a generally cylindrical body for internal in-situ repair of pipe shaped objects comprising:

an elastomeric seamless composite closed body having a generally cylindrical shape formed of at least one layer of a flexible elastomeric material having a first inner surface and a second outer surface, a plurality of nonmetallic, electrically

conductive fibers selected from a group of fibers consisting of fibers containing carbon filaments and fibers containing graphite filaments located substantially throughout the length of the cylindrical shaped body between the first inner surface and second outer surface of the flexible elastomeric material;

at least one electrically conductive cable port connecting the electrically conductive fibers to an electrical power source; and

at least one air port for inflation and deflation of the closed body.

51. (New) The inflatable heating device of Claim 50 further comprising components to monitor heat of at least a portion of the elastomeric seamless composite and to control the electrical power source.

52. (New) The inflatable heating device of Claim 50 wherein the generally cylindrical body has an outer diameter sized to allow the second outer surface to contact an inner surface of a repair object to transfer electrical resistive heat energy created by the conductive fibers located between the first inner surface layer and second outer surface layer when energized by the electrical power source and the body is inflated.